Reliable Framework for Unreliable RFID Devices

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***Abstract*—The current large scale RFID deployment requires careful consideration of the unreliable property of RFID devices, the massive scale of generated data and processing of data in a scalable and timely manner. We propose a path based architecture for item tracking named RF^{2}ID and a path based system for item location named Guardian Angel that addresses these challenges.**

Keywords- RFID Middleware;Item tracking; Item location;

I. INTRODUCTION

RFID technology is rapidly becoming part of today's life through a variety of applications. With the ubiquity of RFID deployments, there exist several challenges, especially when these streams are distributed across multiple geographic locations. First, the amount of data generated is very large; second, the streamed data and possibly legacy data must be fused together in a time-sensitive manner; and finally, the overall system has to be able to manage complexities in a scalable manner. RFID readers use radio waves to communicate with electronic tags which vary in type, capability and size. Passive tags are gaining considerable amount of attention as a low cost solution for automating a wide range of applications. However, the limitation of passive tags is their unreliable behavior [5][6][7]. A middleware for RFID deployment requires careful design considerations. We present our path based solution -RF^{2}ID and GuardianAngel.

II. PATH BASED SOLUTION APPROACH

Most RFID middleware support two major application categories: *item tracking* where mobile objects are tracked by static readers (e.g., supply chain scenario [10]) and *item location* where mobile readers find out object of interest (e.g., a search and rescue scenario). Both applications have an internal data flow that follows a *path*: the tagged items follow a path in item tracking applications and the mobile reader creates a path as it awakes the tags in the environment.

A. Reliable Framework for RFID:RF^{2}ID

RF^{2}ID [25] as presented in Figure 1-(a), uses two main system abstractions: (1)*Virtual Readers (VR)* are the distributed computational elements that are geographically distributed across the region to manage RFID devices in that particular area. (2) The VRs create a logical communication abstraction named *Virtual Path (Vpath)* that follows the actual data flow to increase the system level reliability. Name server keeps information about global status about the system components,

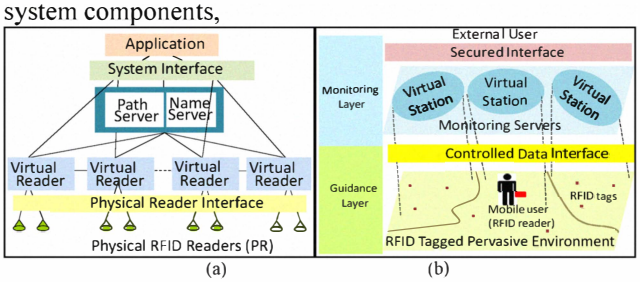

Figure 1. System architecture of (a) RF^{2}ID (b) GuardianAngel

and the path server keeps the information regarding logical paths. The strength of the proposed system is its ability to handle large scale data reliably along with real time query processing using the path abstraction. RF^{2}ID is also able to dynamically manage resources [24] using the Vpath and VR abstraction using load shedding based resource management techniques named as *time based load shedding* and *space based load shedding* where the system makes cooperative decision among the VRs to shed some amount of load across the logical path without significantly decreasing system performance.

B. GuardianAngel Middleware for Item Location

The item location applications involve human users in the system and must address the user controlled data dissemination. We propose a two layered system named GuardianAngel [23] as shown in Figure 1-(b) that is organized of the components as (1) the *pervasive environment* (PE) equipped with RFID tags,(2) the *Mobile object* (MO) the mobile device with RFID reader and (3)the distributed computational element named *virtual station* (VS). The MO uses the mobile device to find out detailed guidance information that is controlled by the user. The monitoring layer consisting of distributed VS acts as a monitoring entity that keeps coarse status information that is controlled and disseminated by the MO. The VS also acts as an information repository regarding of the PE. The MO periodically contacts the VS for environmental information and sends a summary of status information of the user. The

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VS and MO use path as an internal mechanism for data transfer here.

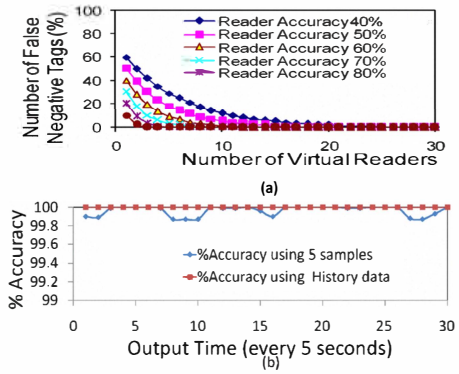

Figure 2. System performance of (a)RF²ID (b) GuardianAngel

III. Related Work

It is interesting to see how our research work falls into various research efforts in the related field.

There have been several recent proposals involving middleware systems for RFID deployment such as the Savant architecture [14], RFIDStack [1] High Fan-in Systems [7] that use a scalable hierarchical architecture. De et al. [9] propose a system for object tracking that builds on the Savant architecture. Similarly, MAX [4] and WinRFID [13] uses a tree-like structure. SCOUT [17] uses two different approaches depending on the application to ensure scalability of object tracking for mobile devices. None of these systems exploit the data flow that is inherent in the movement of items typical of RFID deployments. There are many different systems that consider item location applications such as the Landmarc [18] system using RFID readers to locate tagged items while we we want to use the reference tags as guides of possible location. LotTrack [19] uses RFID technology along with ultrasound technology, the Cricket [20] system uses ultrasound signals, active badge location system [21] uses IR signals and Radar [22] uses RF signal based location information to find out precise location information. We consider mobile objects and intend to provide routing information to the mobile object rather than figuring out the exact current position of the mobile object.The concept of path is used in many different contexts including fault tolerance [5], compiler optimization techniques [3], profiling distributed systems [12][15], and resource allocation [8][16] and navigating OS layers as in Scout OS [2] and service composition done in the Ninja project [10]. Our work is inspired by the use of paths in these various contexts.

IV. Conclusion

We have presented middleware solutions for item tracking named RF²ID and for item location named GuardianAngel using a novel path based system abstraction to improve the overall system reliability for unreliable RFID devices. The proposed solution shows improved system performance in a scalable manner for large scale deployment. We intent to explore the performance of the proposed systems in a constraint based large scale application scenarios.

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